CIRCADIAN CHANGES OF FORESTOMACH MOTILITY AND OF RUMINATION IN CAMELS

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Introduction

Camels achieve a high digestibility of cell-wall constituents due to a long retention time of feed particles in the forestomach (Lechner-Doll, 1986). Forestomach anatomy, histology and motility in camels (Heller et al., 1986) and in llamas (Luciano et al., 1979; Heller et al., 1984; Gregory et al., 1985) are strikingly different from those in ruminants; principal biochemical reactions of digestion, on the other hand, seem to be quite similar. As in domestic ruminants only the rather small particles can leave the forestomach (Lechner-Doll, 1986); however, the threshold in particle size above which only little material passes from compartment 1 (C1) and compartment 2 (C2) is higher (3-5 mm) then in sheep and cattle. Therefore, motility of C1 and C2, motility in the canal between C2 and compartment 3 (C3) and rumination behavior may have a major influence on the selective retention of particles in the forestomach.

The objective of this study was to investigate the circadian rhythm of forestomach motility and rumination in camels.

Materials and Methods

Forestomach motility

Experiments were carried out on fistulated camels (*Camelus dromedarius*), weighing 250-450 kg at the Faculty of Veterinary Science, Khartoum. Animals were fed with dried abu sabeen (a primitive sort of sorghum with a high fiber content) and 1 kg/day concentrates. Feed was offered from 8:00-13:00 h. Air-filled latex balloons (3-15 ml) anchored with lead weights and attached to polyethylene tubes (1.8 mm diameter) were placed in the cranial and caudal part of the C1. The tubes of four balloons (one in C2, two in the canal and one in the proximal part of C3) were attached together. Tubes were connected to pressure transducers (Statham P23Db) and the pressure was recorded simultaneously by a four-channel recorder (Watanabe WTR 331).

Rumination

A foam rubber-filled balloon (length 15 cm, diameter 3 cm) was fixed at the halter of each camel below the lower jaw. Thereby jaw movements could be recorded as described above.

To evaluate the influence of the feeding time on rumination behaviour the animals were fed with abu sabeen (a) *ad libitum*, (b) from 7:30-11:30 h and (c) from 19:30-23:30 h. Jaw movements were continuously recorded in 3 animals for 8 days during each feeding regime.

Results

Two different types of contraction sequences (A- and B- contractions) could be distinguished in the camel. A-contractions started with a contraction of the C2 together with a relaxation of the canal between C2 and C3, followed by a contraction of the caudal part of the C1 approximately 4 sec later. B-contractions started with a contraction of the cranial part of C1; about 9 sec later a contraction of C2 and a contraction of the caudal part of the C1 was observed. In nearly 50% of the B-contractions the canal relaxed during the contraction of the C2.

During feeding, the frequency of motility was high, and pauses were not visible; up to 130 A- and B-contractions per hour were recorded. The relation between the number of A- and B-contractions was approximately 1:6. After feed was removed the absolute number of contractions decreased to 80-100 contractions per hour, but a considerably higher proportion of A-contractions was observed (A:B about 1:2-3). This postprandial

period lasted 6-8 h and was followed by a resting period until approximately midnight; the number of contractions decreased to 70-80 contractions per hour with an increasing portion of B-contractions. During the postprandial and especially during the resting period cycles with a length of about 5 min with 6-10 contractions were observed followed by a pause of 1-2 min.

Rumination started after midnight and lasted, with breaks of 30-60 min, until the next feeding time at 8:00 h. During rumination motility increased considerably up to 150 contractions per hour. Each rumination cycle started with a B-contraction followed by another 1-2 B-contractions. A-contractions appeared rarely (A:B about 1:7). Each rumination cycle consisted of 57±11 jaw movements (observation of 3 animals, each animal 50 cycles). After swallowing the bolus the next cycle started 12±5 sec later. Eructation was observed during the whole day and occurred after a contraction of the caudal part of the C1.

When camels were fed *ad libitum* they spent 8 h/day eating, 11 h/day ruminating and 5 h/day resting. Rumination activity occured mainly during the night with maximum values between 1:00 and 6:00 h. When feed was offered only from 7:30 to 11:30 h or from 19:30 to 23:30 h rumination was observed as well mainly in the early morning hours and only little rumination activity was seen during the day.

Discussion

The circadian rhythm of forestomach motility in the camel is comparable to that measured in domestic ruminants with an increased frequency of contractions during feeding and rumination and a reduced motility during rest. As in llamas, forestomach motility in camels consists of A- and B-contractions. However, there seems to be some peculiarities in camels; during feeding and rumination motility seems to be more or less continuous with a high frequency of contractions. In contrast to Heller et al. (1986) we observed a marked relaxation of the canal between C2 and C3 during the maximum contraction of the C2; probably digesta passage occurs at this time. Cycles with a length of 5 min with 6-10 contractions followed by a pause of two minutes as described by Heller et al. (1986) were found only during the postprandial and the resting period; in contrast to llamas motility cycles started sometimes with B-contractions, and A- and B-contractions occured during the cycle without any systematic order. There is some evidence that digesta passage into the C3 may occur as well during B-contractions.

As shown in our study and by Lechner-Doll (1986), rumination in camels started after midnight and lasted until the next morning. In contrast to domestic ruminants rumination time seems to be rather independent of the feeding time. The maximum of rumination in the early morning hours may be considered as a mechanism to achieve a prolonged retention time of particles in the C1 and C2. Particles have to be reduced in size before they can pass into the C3. If rumination occurs after a rather long lag period particles remain for a longer time in the forestomach, and cellulose digestibility may be improved.

(**Key Words**: Forestomach, Motility, Camel)

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